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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM -- SOVIET-BLOC ACTIVITIES

Table of Contents

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Czechoslovak Journal Reveals Launching Site and Other Details on MECHTA Rocket

The following is a full translation of an article which appeared in a June 1959 issue of a Czechoslovak paramilitary aviation jounal. According to a statement at the conclusion, the article was developed on the basis of "data from the foreign press." The title of the article is "Technical Details on the Cosmic Rocket." It is illustrated by four uncaptioned photographs of what appear to be (1) a meteor-tracking camera setup, (2) a large circular radar antenna, (3) a missile-launching gantry on which a rocket stage is being hoisted, and (4) a technician seated before an unidentified instrument and holding a sheet of paper.

While the Soviet cosmic rocket has already negotiated hundreds of thousands of kilométers on its way around the sun, it is only now that technical details regarding its design, method of launching, and the results of its observations are appearing in the foreign press. Western rocket experts in no way conceal their surprise over the sophistication of Soviet rocket technology. This surprise is attested to by their public announcements over the radio, on television, and in the press.

Let us consider the progress of the preparations and the launching, as well as the guidance and tracking of the Soviet cosmic rocket during the historic days of January.

On 2 January 1959, at 0900 hours Central European time, a threestage rocket was launched from the area northeast of the Ural Lakes, on the dividing line between Europe and Asia (47 N, 62.5 E). The fact that all systems of the rocket functioned reliably to the end must be considered an extraordinary success. Transistors and printed circuits were used exclusively in the five transmitters of the rocket, four of which transmitted scientific measurements with the fifth serving as a reserve. By releasing 5 grams of sodium, which formed a visible sodium cloud at a precisely determined time, it was possible to measure independently the trajectory of the rocket. The evaluation of this photo-theodolite observation required one week, whereas the complete evalution of scientific radio signals requires something more than 6 months.

Design

The Soviet cosmic rocket, designated MECHTA CH-10, was composed of three stages. The first stage was a modified intercontinental ballistic missile. A rocket motor from a modified intermediate-range ballistic missile was used for the second stage. The third stage was a special design, intended only for this one purpose. Unlike the Sputniks, the first stage of MECHTA had two auxiliary solid-propellant rocket motors, to permit it to overcome the effect of gravity with greater certainty.

Propulsion Units

The liquid fuel used was a hydrocarbon, with a boron additive; liquid oxygen was used as an oxydizer. The ratio of fuel to oxydizer was the same for all stages, namely 2.4 : 1.

The first stage developed a total thrust (at sea level) of 300 tons (the main motor developed a thrust of approximately 220 tons while the auxiliary motors developed about 40 tons each). The auxiliary motors accompanied the rocket to a height of about 2,000 meters; at this point, the thrust developed by the main motor increased by 16 percent, that is to say to about 255 tons. After first stage burn-out, the second stage ignited; however, the first stage did not separate for an additional 2.5 seconds, in other words, not until the second stage had developed maximum thrust. The third and last stage of the rocket separated in a similar manner.

The exhaust nozzles and combustion chambers of the rocket motors were lined with a layer of tungsten. As in the case of the Sputnik vehicles, the rocket motors of MECHTA were equipped with a mixing chamber, located in front of the actual combustion chamber. This arrangement made it possible to attain a pressure of 24.6 kg/cm^2 in the combustion chamber which, by expanding in the exhaust orifice, dropped to 0.7 kg/cm^2. Despite a working temperature of approximately 3,200 degrees centigrade, the allowable temperature of the walls of the combustion chambers and exhaust nozzles was lowered to 600 degrees centigrade by an efficient cooling system. The coolant was the actual rocket fuel, circulated through special channels around the combustion chambers. Combustion chamber wall temperature was measured by thermocouples which regulated the flow of fuel through the channels. After warming up in the cooling system, the warm fuel was returned to the fuel tanks where it was mixed with cold fuel. The injection pressure of the fuel varied from 135 to 180 kg/cm^2, according to the thrust required to maintain a pre-determined speed. The required thrust was determined by an integrator which worked in conjunction with the stabilizing gear of the third stage. The injectors for fuel and oxygen in the third stage rocket motor were equipped with magnetic needle valves; the valves were activated by magnetic contacts which were controlled by perforated program cards.

The fuel pumps in all three stages were driven by steam turbines; burning gases, taken from the combustion chamber, were used to produce the steam. At blast-off, when there was as yet an insufficient surplus of burning gases, a special compressor was used.

The success of the entire experiment depended on the accurate functioning of the propulsion system. After reaching the desired velocity, it was possible to shut off the third stage motor after 0.1 seconds.

Launching

Five seconds prior to blast-off, all gyroscopes of the rocket had to be working at maximum revolutions. Similarly, the rocket motor of the first stage had to be firing. In case some of these conditions were not fulfilled, blast-off could be automatically halted. During the final 5 seconds prior to blast-off, the total weight of the rocket was determined, including full fuel tanks, and "transferred" to the main computer. Simultaneously, the exterior fueling lines were shut off and the flow of fuel from the fuel tank of the first stage was turned on. All of these actions -- during the final moments before firing -- were completely automatic. At the instant of blast-off both auxiliary solid-propellant motors began functioning and the rocket was released from the take-off structure.

Guidance

The guidance system was installed in the third stage of the rocket. The ground control station was located on kilometer from the firing base. The guidance system operated in accordance with a previously prepared program; this programmed guidance was, however, supplemented by additional long-range guidance using a directional beam.

The optimum flight path had been previously fed into perforated aluminum cards, whence, with the aid of two electronic computers, this information was fed to the guidance system. A similar perforated aluminum card also controlled the revolutions of the antenna of the guidance transmitter on the ground. Both guidance computers in the rocket were synchronized with the one on the ground. The directional beam transmitter, located on the ground, had an output of 5,000 watts and operated on the 12-centimeter band; its antenna was 26 meters in diameter.

Giant electronic computers determined adjustments in the flight path. Even the most minute changes in the shape of the antenna reflector, caused by temperature influences, were measured by thermocouples. Additional computers worked out adjustments for the entire guidance system. This method permitted the guidance antenna, which transmitted the directional beam, to maintain the correct directional focus.

Flight Path Monitoring

The flight path of the rocket was monitored by thirteen ground stations (one main station and 12 secondary stations scattered throughout the USSR), equipped with Doppler, radar, and photo-theodolite instruments. All three equipment systems were mounted on a common mount which could rotate on its horizontal, as well as vertical axis. All stations, including the main station, had identical equipment and were interconnected by cables.

Ten minutes before blast-off, the main station began transmitting synchronized time signals, temperature, humidity, and atmospheric pressure data, and information on the velocity and direction of the wind. The secondary stations checked this data and made corrections proper to their instruments. Each secondary station had the identical punch cards for programmed guidance as the main station.

After launching, each station transmitted signal information to the main station as soon as it intercepted the cosmic rocket. The data measured by all stations was constantly processed by a central computer at the main station, which then transmitted correction signals for use both by the computers at the secondary stations, as well as in the rocket.

Each secondary station which, for any reason, lost synchronization with the main station was automatically disconnected from contact with the central computer. ("Technical Details on the Cosmic Rocket," by Engr J. Pokorny; Prague, Kridla Vlasti, 9 Jun 59)

II. UPPER ATMOSPHERE

Some Important Results in the Study of the Upper Layers of the Atmosphere and Cosmic Space

A seminar at the Institute of Physical Problems was described in a recent article, the translation of which follows:

At the 341st session of the seminar, Prof I. S. Shlovskiy (State Astronomical Institute imeni P. K. Shternberg) delivered a talk on certain physical investigations of cosmic space and in particular on the possibilities of obtaining information on it through the use of artificial comets.

The environs of the Earth are considerably less well known to us than distant portions of the universe. It has been established that interstellar gas has a concentration of the order of unity per cubic centimeter. Even the central regions of the galaxy have been studied by radio astronomical methods and magnetic fields in interstellar space have been evaluated and found to be of the order of 10^{-5} gauss. However it is impossible to say definitely what is the density of interplanetary gas.

Many facts, however, testify to the existence of such a gas. The presence of the alpha line of the Lyman series in the spectra of certain regions indicates the existence of interplanetary clouds of hydrogen with a density of several tenths of an atom per cubic centimeter. The polarization of zodiacal light is attributed to electrons which enter into the composition of interplanetary gas. This polarization corresponds to a density of approximately 500-600 electrons per cubic centimeter. Data on "whistling atmospherics" also lead to the conclusion that the electron concentration is of this order.

Nevertheless, certain facts speak against the existence of interplanetary gas. Academician V. F. Fesenkov has shown that there exists a phenomenom of "sweeping out" of gas from the solar system by corpuscular and light radiation emitted by the Sun. The polarization of zodiacal light can also be explained by dust particles located in interplanetary space and in the upper layers of the atmosphere. The solution of this problem is very important for astrophysics and geophysics.

A Doppler shift toward the violet has been observed in the lines of the Balmer series of the spectrum of the aurora polaris. This indicates that hydrogen atoms move in the direction of the Earth with a velocity of 1,000 kilometers per second and more. This corresponds to energies of 5 kilo-electron-volts. Rocket investigations in the zone of aurorae polaris disclose dense streams of electrons with energies of from one kilo-electron-volt to tens of kilo-electron-volts, although in the corpuscular flow of the Sun, they can have only about one to 2 electron-volts. At the same time, positive particles in this flow have energies of one kilo-electron-volt to 0.5 million electron-volts. There this occurs an unusual "pull" of the electron energies up to the proton energies. In addition, a certain, though very inconsiderable, number of the particles possess extremely high energies. These facts provide some basis for assuming the presence of an interplanetary gas of a definite concentration and that the redistribution of the energy between the particles occurs through collisions with atmos of the gas.

A cosmic rocket was necessarily required to carry out the first direct measurements on the interplanetary gas. Analysis of the data obtained with it can uniquely resolve this complex question.

In launching the rocket there was the problem of optically observing it, if only at one point in the sky. As is known, this was accomplished with the aid of an artificial sodium comet.

In an earlier firing of a geophysical rocket to an altitude of 40 kilometers, a sodium comet was also used and the density of the atmosphere at this altitude was successfully calculated on the basis of the character of the diffusion. There was good agreement with the figure obtained from investigating the slowing down of satellites ($2.5 \cdot 10^8$ atoms per cubic centimeter.) The number of free electrons at this altitude, as measured by instruments on the rocket, was on the order of 10^6 per cubic centimeter. It is evident from this that the degree of ionization is very slight.

The prospects of the "comet" method is a question of some interest. Sodium has the drawback that it is contained in the atmosphere of the Sun in considerable quantities and it almost completely absorbs those wavelengths which excite the atoms of the artificial comet. Hence, only 5% of the Sun's light is utilized. The selection of more effective substances is now being made and it may be assumed that the question of the possibility of observing an artificial comet at an Earth-Mars distance has been resolved in the affirmative.

The diffusion method can be used to measure not only the density of a given medium, but also its temperature (from broadening of the spectral lines.) A cloud of ionized vapor of a corresponding substance could offer great possibilities since ions have a smaller free path length. Comets of this type are obviously the most useful signal at very great distances. An atomic explosion, for example, at the distance of the Moon would give a brightness corresponding to a star of 0 or 1 magnitude, but only for a fraction of a second. To make it possible for signals from a radio transmitter at interplanetary distances (Earth-Mars) to be picked up by even the most sensitive radio telescopes, the transmitter power must be at least 100 volts.

A second talk on the investigation of cosmic rays with the aid of satellites was given by Candidate of Physicomathematical Sciences A. Ye. Chudakov (Physics Institute imeni P. N. Lebedev.) The most unexpected discovery made with the aid of artificial satellites was the observation of intense flows of high-energy particles at great altitudes. It was noted in the firing of the first and third American satellites to an altitude of 1,000 to 2,000 kilometers that the operation of the particle counters ceased above 1500 kilometers in the Equatorial region. Van Allen and his colleagues came to the conclusion that this occurs because of the huge number of particles, in their estimate on the order of 30,000 to 35,000 which hit the counter per second.

Soviet science played a decisive role in the investigation of this notable phenomenon at its explanation. A scintillation counter which registered the number of photons with energies greater than 36 kilo-electron volts was installed on the third Soviet satellite. The counter had a 4X4-centimeter cylindrical crystal of sodium iodide. It was also used to measure the degree of ionization in the crystal per unit of time. The resolving power of the counter with respect to time was 10^{-6} seconds. As the satellite entered the region close to 60° N, the intensity of the particle count rose sharply but the total ionization did not increase considerably. The total ionization energy for 100 particles per square centimeter per second was 10^7 electron-volts per square centimeter per second, which gives for a single particle 10^5 electron-volts. These could not be electrons since the instrument was protected by an aluminum shell with a thickness of 3 millimeters, through which electrons of this energy cannot pass. Consequently, gamma-quanta had fallen on the crystal counter. Gamma-quanta however, are not deflected by a magnetic field and the intensity of their flow could not depend on the geographic latitude. The only nonconflicting explanation of the observations could be that the counter records gamma-quanta produced in the moderation of electrons with energies of 10^5 electron volts in the aluminum casing. The number of such electrons at an altitude of 300-400 kilometers in the region 60°-65° N latitude exceeds the number of particles in the flow of cosmic rays by a factor of approximately 10,000. This zone of charged particles was observed by Soviet researchers. Verification of the first American data on the existence of a high intensity zone in the region of the Equator was obtained simultaneously.

Satellite signals in the equatorial region were recorded on the Diesel motor ship Ob' and at several foreign stations, which sent their readings to the USSR. The intensity of the ionization in the crystal of the counter varied only slightly with altitude in the 800-1,600 kilometer interval but exhibited a strong dependence on latitude. In contradistinction from the first zone, the particles in this case are concentrated in a region of low latitudes (-40° - +40°). The composition of the particles here is also substantially different from the first zone. We are obviously dealing in this region with protons of energies of the order of 100 million electron-volts or more.

S. N. Vernov and A. I. Lebedinskiy are of the opinion that high energy protons and low energy electrons are produced in the beta decay of neutrons knocked by cosmic rays out of the nuclei of atoms of the upper layers of the atmosphere. These particles are then captured by the magnetic field of the Earth in a "magnetic trap" and move from the northern hemisphere to the southern and back. It follows from the data obtained that electrons are accumulated at altitudes up to one radius of the Earth. The idealization of a "magnetic trap" of the Earth and possibly the presence of electrostatic fields in the upper atmosphere impose a time limit on the motion of these particles around the Earth. The electrostatic field, for example, which is directed along parallels, either holds the particles to the Earth or draws them beyond the limits of the "magnetic track." The injection of neutrons is sufficient, however, to constantly replace the supply of particles in this region. ("Important Physical Investigations: Seminar at the Institute of Physical Problems, Academy of Sciences USSR. Certain Results in the Study of the Upper Layers of the Atmosphere and Cosmic Space," by M. A. Korets, Moscow; Moscow, Priroda, No 7, Jul 59, pp 76-78)

OH-Bands in Infrared Spectrum of the Night Sky

Results are given of measurements of the relative and absolute intensities of the hydroxyl bands in the near infrared region of 8,200-11,200 angstroms in spectra of the night sky obtained during the winter of 1956-1957 at the Byurakansk Observatory ($40^{\circ}21'$ N, $44^{\circ}15'$ E). The SP-50 spectograph with electronoptical converter (dispersion 160 angstroms per millimeter; resolution 7 angstroms) was used to obtain the spectra with exposures of 4-10 hours. The absolute intensities of the OH-bands were used in the determination of the population of various vibration levels. Population increases smoothly with decreasing V' (of the upper vibration level). On the basis of the distribution of intensity in the P-branch, a determination was made of the rotational temperature, which varied from night to night, averaging 233 plus-minus 16 deg K. ("Hydroxyl Emission of the Upper Atmosphere," by N I Fedorova, Institute of the Physics of the Atmosphere, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 6, Jun 59, pp 836-846)

Doppler Lines and Luminosity Distribution in Auroral Hydrogen Emission

Formulas are derived for the luminosity distribution and Doppler lines of auroral hydrogen emission, assuming a mono-energetic beam of protons. The integral expressions for the luminosity curves and zenith line agree with data obtained earlier (Chamberlain, J. W., Astrophys. J., 126, 1957, p 245; Omholt, A., J. Atmos. and Terr. Phys., No 9, 1956, p 18), after a correction of the value of the angular distribution function of the protons N (ϕ). A new formula is given for the horizontal Doppler line. ("On Doppler Lines and Luminosity Distribution Curves for Auroral Hydrogen Emission," by B A Bagaryatskiy, Institute of the Physics of the Atmosphere, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya No 6, Jun 59, pp 858-864)

Twilight Luminescence of Thin Layers in Upper Atmosphere

Some results are given of a processing of data on twilight observations made in the period 1952-1957 in the Abastumani Astrophysical Observatory, which indicate the possibility of a twilight luminescence of thin layers of the atmosphere at altitudes of 35-40 and 90-100 kilometers in the portion of the spectrum around $\lambda = 9,400$ angstroms.

These investigations were part of a program of systematic observations in the infrared region begun in the autumn of 1952 with the photoelectric photometer devised by S. F. Rodinov and his associates (ZhTF, Vol 19, No 2, 1949, p 189).

A quantitative analysis of the observation data was obtained by locating on the twilight curve ($\log I.\ H_{ef}$) the dependence of the function $\frac{1}{I}\frac{dI}{dH_{ef}}$ (I = intensity of twilight illumination) on the effective height H_{ef} of the layer which diffuses the light.

An examination of the curves shows that a study of such spectral characteristics, with more voluminous material and in various parts of the spectrum, might help to locate that portion of the spectrum in which a more careful investigation of the twilight luminescence should be made. It is also noted that the observed spectral effects may be caused in part by a selective absorption in the atmosphere (O_3, H_2O), and that additional atmospheric glow may be caused by the luminescence of the atmosphere itself and an aerosol diffusion of light.

The interpretation of the curves is considered a sufficiently accurate only for those curves with well expressed maxima, since the error in the determination of the numerical values of the function $\frac{1}{I}\frac{dI}{dH_{ef}}$ may be rather large. A value of this function was computed for every two kilometers; the relative error in these determinations nevertheless amounts to about 10 percent at altitudes of up to 80 kilometers and increases to 30-40 percent at altitudes of 100-120 kilometers. Additional systematic measurement errors may be related to effects (neglected here) of the absorption of light by H_2O and O_2 molecules in the 6,884-, 7,621-, and 9,419-angstrom bands. In many cases the variations of the relationship of the above function to H_{ef} considerably exceed the value of the error. ("Spectral Investigations of the Twilight Sky in the Infrared Range," by T G Megrelishvili, Abastumani Astrophysical Observatory, Academy of Sciences Georgian SSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 6, Jun 59, pp 910-918)

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III. GRAVIMETRY

Generation of Geoelectromagnetic Field Far Removed From Source

In an effort to gain more precise information on the geoelectric cross section, a study was made of the asymptotic behavior of the process of the generation of an electromagnetic field at great distances from the source of excitation and of the possibility of interpreting such a phenomenon.

The article presents the case of the excitation of a grounded dipole as an asymptotic representation of the generation of an electromagnetic field at great distance from the source of the field. The analogous case of the excitation of the field of a magnetic loop is likewise considered.

A formula is derived to express the components of the electromagnetic field in terms of inverse powers of the distance from the source of excitation, and the conditions are defined for computing the coefficients of all orders introduced into the derived expressions.

The article also considers a homogeneous layer upon a nonconducting base and shows that, on the basis of the asymptotic representation, the field can be determined as a conductivity layer, as the value $S = \sigma l$ (σ = conductivity, l = thickness of the layer). It is shown that, if, in the construction of the experimental curves for the magnetic field, $\lg H_z$ (magnetic field) is plotted on the vertical axis and the time t on the horizontal axis, the formula

$$S = \frac{1.9 \cdot 10^3 t_o}{\rho^2}$$

can be used, where the distance between the excitation electrode and the measuring electrode is measured in kilometers. ("Asymptotic Behavior of the Process of Generation of an Electromagnetic Field," by A N Tikhonov and O. A. Skugarevskaya, Institute of the Physics of the Earth, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 6, Jun 59, pp 804-813)

IV. METEOROLOGY

Direct Measurement of Turbulent Flow of Heat in the Ground Layer of the Atmosphere

A new method for directly measuring turbulent flow of heat was developed in 1957-1958 at the Acoustics Laboratory of the Institute of Physics of the Atmosphere, Academy of Science USSR. Up to this time measurements of this important factor in the heat balance between the atmosphere and underlying surfaces were determined mainly by indirect methods which did not produce sufficiently accurate results.

Pulsations of the vertical component of wind speed W' were measured with the aid of an acoustical microanemometer which operates on the principle of measuring the time of propagation of a sound wave in moving air relative to stationary microphones. The microanemometer contains two 2-millimeter wave radiators and two microphones of analagous construction. In measuring W' the radiators and microphones are placed 2.5 cm apart in a vertical plane. Frequence of continuous ultrasonic oscillations on which the measurements were conducted was 75 to 100 kilocycles. The magnitude and sign of W' were determined according to the phase shift of the sonic wave arriving at the microphone. Sensitivity of the microanemometer is 9 cm/sec v and does not depend on the mean wind speed. Output voltage is linearly dependent on the measured wind speed and range of the instrument is ± 2m/sec. The microanemometer measures pulsations of wind speed in the frequency range of 0 to 700 cycles without distortion. Inherent noises of the instrument did not exceed (in conversion to wind speed) 1 cm/sec. The acoustical circuit shuts out the effect of temperature pulsations on the measurement of wind speed.

Temperature fluctuations were measured with a pulsation resistance thermometer containing a pickup in the form of a 20 mm length of 20-micron platinum wire connected into the bridge circuit. Time constant of the pickup is approximately 0.01 sec. A thermistor with indirect heating is connected in parrallel to one of the arms of the measuring bridge. Heating of the thermistor is accomplished by the bridge unbalance current in the negative feedback circuit of the voltage amplifier. An integrating RC-circuit with a large time constant is connected into the negative feedback circuit. With such a negative feedback circuit, smooth (with a time constant greater than 100 sec) following of changes in the mean temperature of the air by the "zero" of the thermometer is possible. The necessity of instrument alignment during measurements of temperature pulsations is completely removed with such a thermometer.

Maximum sensitivity of the thermometer is 0.15°C/v and the amplitude characteristic (for pulsations) is linear within the limits of ± 2°. Inherent noises of the thermometer are less than 0.01°. These qualities permit high sensitivity to pulsations in a wide range of changes in mean temperatures.

Voltages U_1 and U_2 which are received at the output of the microanemometer and thermistor are respectively proportional to the instantaneous values of the vertical component of the wind speed $U_1 = k_1 W'$ and the pulsations of temperature $U_2 = k_2 T'$. These voltages enter at the imput of a correlometer in which the current I at the output is proportional to the mean product with respect to time of the two input voltages $I = k_3 \overline{U_1 U_2}$. This current is measured directly by a needle-pointer instrument with a scale which can be graduated directly into values of the turbulent flow of heat:

$$q = k_4 I = k_5 \overline{W' T'}.$$

With the above indicated sensitivities for the microanemometer and pulsation thermometer and a correlometer of maximum sensitivity, graduation of the output instrument was 0.02 cal/cm^2 min. Averaging of the product of the instantaneous values $U_1 U_2$ is accomplished by means of the integrating RC-circuit with a time constant of 100 seconds. Pickups of both the microanemometer and pulsation thermometer were attached to the detector head so that the distance between the two pickups was about 3 cm.

In September 1958 a series of direct measurements of turbulent flow of heat were conducted in the open steppe. Measurements were on a level area with dimensions of 700 x 600 meters and were accompanied by measurements of temperature and wind profiles according to altitude. Richardson Numbers were calculated according to results of these gradient measurements. Measurement and statistical analysis (with the aid of specially developed spectrum and distribution analyzers) of temperature pulsations and wind speed components were conducted parallel with measurements of the turbulent flow of heat. The mean quadratic values for fluctuations of temperature and the vertical component of wind speed ($\sqrt{\overline{T'^2}}$ and $\sqrt{\overline{W'^2}}$) and values of heat flow $q = k \overline{W' T'}$ obtained from processing of the pulsation measurements made it possible to calculate the coefficients of correlation $r_{W' T'}$:

$$r_{W' T'} = \frac{\overline{W' T'}}{\sqrt{\overline{T'^2}} \sqrt{\overline{W'^2}}}.$$

The flow of heat was measured alternately at two-minute intervals at altitudes of one and 4 meters. A total of 360 measurements of q at an altitude of one meter and 80 at 4 meters were taken. Processing of results of mesurements showed that a 100-second averaging which corresponds to each separate measurement was insufficient as the values obtained for q were unstable. It was found that in order to obtain stable values of q it was necessary to average a 10-minute interval.

Comparison of the coefficients of correlation $r_{W'T'}$ with corresponding (according to time) Richardson Numbers showed that with an increase in instability ($Ri \longrightarrow -\infty$) there is also an increase in the correlation W' T'. This is considered understandable from the physical standpoint since, with the growth of instability, convection plays an increasingly larger role in the transfer of heat.

Although simultaneous measurements of q at altitudes of one and 4 meters were not conducted, nevertheless from the results obtained it was considered that the values of q at these two altitudes were very nearly equal. The mean value of the ratio of these values, q_4/q_1, obtained according to 14 values of q_4 and q_1 measured at identical times of the day was equal to one. This is in good agreement with theoretical considerations from which it follows that the turbulent flow of heat should not change with altitude. It is noted that in the determination of heat flow by indirect methods the difference in the magnitude of q at different altitudes is quite considerable. ("Direct Measurements of the Turbulent Flow of Heat in the Ground Layer of the Atmospher," by V. M. Bovsheverov, A. S. Gurvich, and L. P. Tsvang, Institute of the Physics of the Atmosphere, Academy of Sciences USSR; Moscow, Doklady Akademii Nauk USSR, Vol 125, No 6, 21 Apr 59, pp 1242-1245)

Some Contributions by Meteorological Rockets in the Study of the Stratosphere

Explorations in the atmosphere with meteorological rockets during the past ten years have established that the composition of air up to the lower strata of the ionosphere is the same as that at the earth's surface.

Temperatures in the stratosphere have also been determined. In the moderate latitudes, up to an altitude of 10-11 kilometers, air temperature increases 6-6.5 degrees [centigrade] per kilometer of ascent. Then, up to an altitude of 35 kilometers, lies an air mass with relatively invariable temperatures. From 35-50 kilometers, temperature increases and reaches a maximum of near zero at 50 kilometers. Above this height, to the upper limits of the stratosphere, temperatures again fall, and at an altitude of 80-90 kilometers they may reach 90 degrees below zero.

One of the most interesting of recent discoveries is the existence of seasonal changes in the "climate" of the stratosphere. Geographical peculiarities have also been found, in that temperature and pressure distributions vary according to latitude. These factors all have an effect on weather conditions at the earth's surface.

It has only recently been established that intrusions of polar or tropical air masses, cyclones, and anticyclones affect the stratosphere to considerable heights above the earth's surface and cause movements of large masses of air. Even the continental character of climate over mainlands and the influence of oceans extend to great heights. ("Explorers of the Stratosphere," by M. Chernenko; Moscow, Pravda, 31 Jul 59, p 6)

Formation of Inversion in Upper Part of Stratus Cloud During Nocturnal Radiation Cooling

In an investigation of the process of nocturnal radiation cooling of the upper part of a stratus cloud and of the atmosphere just above it, whereby the temperature change of the cloud caused by phase transformations of the water was taken into account, a temperature inversion in the boundary layer between the cloud and the atmospher above it was established, and its development was traced with respect to time.

In contrast to the cloud, the layer above the cloud cools very slowly. Calculations showed that during the first two hours this layer cools at the rate of 0.3 degree (for the case of a special water-vapor spectrum) and that further cooling will take place at approximately the same rate. Consequently, about two hours after an initial moment (characterized by a constant temperature change with altitude in the cloud and above it), a temperature inversion of about 7-8 degrees will take place in a boundary layer about 100 meters thick. Later on, this inversion begins to dissipate slowly because of the cooling of the layer above the cloud and, generally within a certain (relatively long) period of time, the temperature change in the boundary layer will again be constant with altitude and the conditions will be established once more for a new abrupt temperature change inside the cloud. Because of the instability of the thin cold layer in the upper part of the cloud, however, other thermodynamic processes (turbulent motion or convection) will start to develop much sooner, which would, for a long time, preclude the possibility of any such a sharp temperature inversion. ("Radiation Cooling of Stratus Clouds," by Ye M Feygel'son, Institute of the Physics of the Atmosphere, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya No 6, Jun 59. pp 847-857)

V. SEISMOLOGY

Passage of Wave Through Widely Separated Layers With Increasing Velocity

An approximation method is used to calculate the intensity of a two-dimensional stationary wave which has passed, with increased velocity, through a series of layers of finite thickness, located at relatively great distances from one another. During passage, no multiply-reflected waves are superimposed on the passing principal wave in the areas between the layers. The results of the calculation are in good agreement with experimental data obtained on models and presented in an earlier article by the author (Izv. AN SSSR, Ser. Geofiz., No 5, May 59).

In the earlier work it was shown that the amplitude of a wave which has passed through a series of layers may be either greater or less than the amplitude of a wave which has passed through one layer with a thickness equal to the sum of the thicknesses of the several layers. In this article the influence of individual parameters on the intensity of the wave is examined, and the possibility is investigated of employing the theory of two-dimensional waves, developed for the acoustic case, to obtain simpler expressions.

The data obtained helps to explain the character of the propagation of elastic waves in stratified media, which is often encountered under real conditions in seismic investigations. ("On the Intensity of a Wave Which Has Passed Through a Series of Layers With Increased Velocity. II.," by I S Parkhomenko, Institute of the Physics of the Earth, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 6, Jun 59, pp 827-835)

Passage of Transverse Polarized Wave Through Two-Component Medium

A solution is given of the problem of the passage of a two-dimensional transverse polarized wave through a well regulated two-component medium. Expressions are obtained for the effective velocity of the transverse wave and of the effective density of the medium. It is shown that, under certain conditions, the medium becomes exponentially absorbing or dispersing.

The expressions obtained for the effective velocity and density represent functions of frequency, which explains the dispersion and absorption in a heterogeneous two-component medium where each of the components possesses neither dispersion nor absorption. Since, with specific frequencies (given geometry and parameters of the containing component and of the interspersed component) the effective velocity may be purely imaginary, a heterogeneous two-component elastic medium may be reduced to an exponentially absorbing medium in the determination of the frequencies.

In the general case, it is possible to obtain the effective parameters of a two-component medium by selecting the geometry and the homogeneous parameters, assuming arbitrary values in the complex region. ("On the Effective Dynamic Parameters of Elastic Media During the Propagation of a Plane Transverse Polarized Wave," by I. M. Khaykovich and L A Khalfin, All-Union Scientific Research Institute of Geophysical Prospecting; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 6, Jun 59, pp 815-826)

Microseisms Produced by Lake Issyk-Kul' Near Alma-Ata

At times during the recording of seismographs of the general type at the Alma Ata Geophysical Station, in addition to the well-known microseismic motions with periods of 5-7 1/2 seconds, regular oscillations in the form of beats with periods of 1.8-3.0 seconds and lasting up to 24-48 hours were also observed. Microseisms with such periods are little known; they are ordinarily observed at seismic stations located on the shore of the sea and are connected with vibrations of the ground caused by the surf.

The Alma Ata Geophysical Station is located in the foothills of the Zailiyskiy Alatay, 40 kilometers from the city of Alma Ata, in a narrow canyon enclosed on all sides by elevations towering about 800 meters above the floor of the canyon. Access is possible only from the north side. The station is far from any possible sources of interferences of a mechanical origin. The nearest small populated place (without even permanent power supply) is six kilometers away and the closest highway runs through northern Talgar, 12 kilometers from the station. The lack of background disturbance is further enhanced by the fact that the seismographs are erected in a tunnel leading into solid rock. The permanent seismographs are the usual type for standard stations in the USSR; $T = 12$ sec; $D = 0.45$; $T_1 = 1.2$ sec; $D_1 = 4$-5. The magnification of the horizontal seismographs is about 3,000 and of the vertical 800.

Investigations showed that the short-period microseisms are caused by the agitation of the water surface of Lake Issyk-Kul' (located 80 kilometers from the station), most commonly as a result of storm winds blowing over the lake during the passage of cold fronts.

The intensity of the microseism depends not only on the force of the wind but also on the direction; the most intense microseisms occur when west winds are blowing at the western shore of the lake at the same time that east winds are blowing at the eastern shore.

The amplitude of the microseisms rapidly attenuates with distance away from the lake, and short-period microseisms are no longer observed at a distance of about 800 kilometers from the lake (Semipalatinsk Seismic Station). The direction of the plane polarization of the motion of the ground during these short-period microseisms depends on soil conditions.

This article represents only a first attempt to analyze the short-period microseisms caused by the agitation of Lake Issyk-Kul'. A whole series of questions on the energetic aspects (the nature of microseismic waves, their attenuation with distance, etc.) are not considered and should be examined further. ("Microseisms of Lake Issyk-Kul'," by N M Gynkina and S I Masarskiy, Alma Ata Geophysical Station; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 6, Jun 59, pp 884-890)

STB-1 Rocket Drill Bores Holes Eight Meters Deep

A newspaper article describes the STB-1 rocket drill as capable of drilling vertical or inclined holes with a diameter of 120-200 millimeters and a depth of eight meters. At the bottom the holes can be enlarged to a diameter of 0.5 meters for the insertion of explosives. The combustion chamber at the end of the drill burns liquid fuel. The rocket drill is said to be many times faster than mechanical drills on hard rock. ("A Rocket That Drills Rocks," by V. Pospelov; Moscow, Promyshlenno-Ekonomicheskaya Gazeta, Vol 4, No 87 (542), 26 Jul 59, p 4)

VI. ARCTIC AND ANTARCTIC

Soviet Research in Antarctica

Great hardships are encountered under the working conditions at the antarctic stations because of extremely low temperatures and low atmospheric pressure. The question has been asked: Has it been worth while to organize any observation stations in this region?

Experience has proved that it has been worth while. The experiments made at these stations have provided valuable material. At the stations Vostok, Pionerskaya and Sovetskaya, norms of human behavior under conditions of high altitude, low temperature, and low pressure were established. This is very important for our efforts to conquer cosmic space. Scientists have obtained important data on the work of equipment and instruments under these conditions....

An important part of the scientific work conducted at interior stations is the study of the lower stratosphere. Frequently strong air currents which affect the climate of the whole Earth originate in these layers of the atmosphere.

Antarctica still has many mysteries to be solved. So far no one can say what natural resources are hidden in the depths of the antarctic earth and in the surrounding seas. Scientists must determine the economic usefulness of the continent. The area around Mirnyy consists of very ancient rocks, almost completely lacking in mineral resources. However, it is assumed that the rock structure in the area adjoining the Pacific Ocean is the same as in the South American Andes, which are rich in mineral resources.

Soviet ships have already circled two thirds of Antarctica. Now they are preparing for new expeditions. The Ob' will sail to the Bellingshausen Sea. A new Soviet station, named after the first discoverer of Antarctica [Bellingshausen] is to be established on the coast of this sea.

The exploration of Antarctica, which is of great interest in the study of geophysics of the Earth, is expanding. New instruments and new means of communication are coming to the aid of scientists. It is quite possible that fast-flying Soviet airplanes will soon be able to make non-stop flights from Moscow to Mirnyy. A new stage in the conquest of the glacial continent will [then] begin. ("Columbuses of Antarctica," Moscow, Moskovskaya Pravda, 12 Jul 59)

Field Party Studies Antarctic Island

Soviet scientists are continuing to conduct complex research in the fields of aerometeorology, geophysics, glaciology, and general geography. Recently a field party made up of scientists of the Antarctic Expedition returned to Mirnyy after spending a month on Drygalski Island. T is huge ice monolith is located almost 50 miles north of the Pravda Coast. The central portion of the island rises about 250 meters above sea level. The edges of the ice dome are covered with crevasses.

Climatic conditions on this island differ considerably from those in the Mirnyy area. During the period from 16 May to 16 June, there were 28 days with snowstorms in Mirnyy, whereas Drygalski Island had only 15 days with bad weather during the same period. The rest of the time it was clear and windless, or only slightly windy.

The study of this island is of great scientific interest. The field party consisted of A. Kapitsa, glaciologist; Yu. Durynin, seismologist; A. Krasnushkin, physicist; L. Khrushchev, astronomer and geodesist; and N. Medvedev, magnetologist. A new geodetic pavilion was erected on the island and the scientist conducted seismic soundings and gravimetric measurements. N. Medvedev, who is spending the second winter in Antarctica, made a magnetic survey of the whole island and discovered a marked magnetic anomaly. Members of the field party determined the thickness of the ice dome, the shape of the island, and conducted observations of the ice movement in the bordering zone. The work was disrupted occasionally by heavy snowstorms, during which the wind velocity reached 40 meters per second.

After a 78-day trek into the interior the Soviet tractor train returned to Mirnyy. The participants in this expedition included S. Shcheglov, A. Khoman'ko, V. Ivanov, and V. Makarov, geophysicists; M. Lyubarets, radioman; and M. Petrov and N. Shafaruk, drivers; they completed the traverse successfully and collected valuable scientific material.

Preparations are now under way for new exploratory trips, both along the coast and into the interior. At the beginning of the antarctic summer a group of the expedition will begin its transcontinental trek to the three poles of Antarctica, -- the south geomagnetic pole, the south geographic pole, and the pole of relative inaccessibility. This traverse, which is to cover a distance of over 5,000 kilometers, will be made with the help of three 34-ton caterpillar snow vehicles, type "Khar'kovchanka." The tractors will be equipped with dural huts made of heat-insulating materials, and with modern radio-navigational instruments, navigators' cabins, radio stations, a scientific laboratory, and a complete lighting system.

The Soviet scientists will conduct glaciological research; seismic soundings; and meteorological, magnetic, gravimetric and general geographical observations in the central regions of Antarctica. -- Prof B. Savel'yev, chief of glaciological team. "On the Glacial Land," (Moscow, Vodnyy Transport, 16 Jul 59)

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